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25 September 2003

US380-1737003

HABS/AKN

Method for the Recovery of Perfluorinated Sulphonic Acid

FIELD OF THE INVENTION

The present invention relates to recovery of spent perfluorinated sulphonic acid and in particular spent perfluorinated sulphonic acid catalyst from residue in alkylation of paraffins with olefins.

BACKGROUND OF THE INVENTION

Perfluorinated sulphonic acids are effective catalysts in the alkylation of a paraffinic feedstock with olefinic alkylation agents such as alkylation of isobutane with propene and butenes as described in US patent Nos. 5,220,095, 5,245,100 and 5,498,820. The alkylation process typically produces various amounts of spent acid catalyst. By-products formed in the alkylation reaction deactivate the spent acid.

To improve process economy of the processes involving perfluorinated sulphonic acid catalysts it is highly desirable to recover spent acid catalyst and recycle the catalyst in its active form.

Several attempts have been made in the past to recover valuable amounts of spent perfluorinated sulphonic acid catalyst from alkylation residues. US Patent No. 6,340,414 thus discloses recovery of spent acid by heating and distillation. Recovery of a fluorinated sulphonic acid from a spent acid product by steps of subjecting the spent acid product to thermal treatment to obtain the acid in its active form and a residue and separating the active acid from the residue by stripping with a stripping agent and sepa-

rating the stripping agent from the active acid by distillation is known from EP-A-1,044,963.

5 By the above known recovery processes still valuable amounts perfluorinated sulphonic acid is contained in a viscous residue being formed during recovery.

10 DK PA 2001 00809 discloses a method to treat such viscous residues for the further recovery of acid by adding an alkyl ammonium salt of the acid to be recovered and subsequently extraction of the acid.

15 Viscosity of the residues increases as the acid is extracted. In some cases the organic part of the residue even solidifies and encapsulates the acid. The method of DK PA 2001 00809 requires therefore vigorous agitation and heating of the residue during extraction of the acid.

SUMMARY OF THE INVENTION

20 We have observed that addition of a hydrocarbon solvent being rich in aromatic compounds improves aqueous extraction of perfluorinated sulphonic acids from a residue being formed use or recovery of the acids as catalyst in alkylation of paraffins.

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Accordingly, this invention provides a method for the recovery of a perfluorinated sulphonic acid from an organic viscous residue by aqueous extraction of the acid from the residue in presence of a solvent mixture, which is rich in aromatic compounds.

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Essentially, any hydrocarbon fraction being rich in aromatic compounds is useful in the inventive process. Light cycle oil, which is a by-product from fluid catalytic cracking of heavy oil, is an example of such a hydrocarbon fraction. Another useful hydrocarbon fraction is reformat gasoline. These fractions contain a mixture of hydrocarbons with a substantial amount of aromatic compounds.

DETAILED DESCRIPTION OF THE INVENTION

Spent acid from alkylation of paraffin alkylation in presence of trifluoromethanesulphonic acid was used in the following examples containing about 70% by weight trifluoromethanesulphonic acid and 30% by weight acid soluble oil (alkylation residue). The spent acid was mixed with 20% by weight triethyl ammonium triflate and then stripped in a stripping column with pentane at 250°C. Most of the acid in the spent acid was recovered in the overhead product from this stripping operation. An organic viscous residue was withdrawn from the bottom of the stripping column. The stripping residue was isolated and employed in the following experiments. The residue contained the entire amount of triethyl ammonium triflate and about 10% by weight of the amount of trifluoromethanesulphonic acid contained in the spent acid.

Example 1

Extraction of stripping residue in presence of reformat.

The extraction procedure was performed at room temperature and at atmospheric pressure. 35g of the residue were mixed with 15% by weight reformat and extracted five times with

50g portions of water by shaking for 30 seconds. An aqueous extract was separated from the residue by centrifugation. The content of recovered trifluoromethanesulphonic acid in each extraction is summarised in Table 1 below.

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After five extractions the residue was extracted with diluted NaOH. Substantially no trifluoromethanesulphonic acid was found in the basic extract.

10 The above procedure was repeated. Results of the second experiment are listed in the Table below.

Table 1

Extraction of residue with water
in the presence of reformat

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Extraction	1 st experiment % recovery of tri- fluoromethanesul- phonic acid	2 nd experiment % recovery of tri- fluoromethanesul- phonic acid
1	95.8	91.0
2	3.53	7.95
3	0.61	0.95
4	0.06	0.04
5	0.01	0.02
Total extracted	100.0	100.0

Example 2

20 Extraction of stripping residue in presence of light cycle oil (LCO).

Extraction of the residue was carried out by the same procedure as in the above Example 1. Results from two experiments are summarised in Table 2. NaOH extract in these ex-

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periments contained 0.1-0.2% by weight of the total amount of trifluoromethanesulphonic acid contained in the residue.

Table 2

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Extraction	1 st experiment % recovery of tri- fluoromethanesul- phonic acid	2 nd experiment % recovery of tri- fluoromethanesul- phonic acid
1	82.4	81.4
2	14.96	16.51
3	1.46	1.21
4	0.53	0.22
5	0.48	0.60
Total extracted	99.8	99.9

Comparison Example 3

50g of the residue were mixed with 50g water. The extrac-
 10 tion was performed at room temperature causing the residue
 to be solidified, so that extraction and phase separation
 were not possible.

Example 4

15 Extraction of residue with anisole.

Residue feed in this experiment did not contain triethylam-
 monium triflate and consisted of trifluoromethane sulphon-
 ic acid dissolved in a highly viscous organic residue. The
 20 residue was dissolved in anisole (methylphenyl ether, meth-
 oxybenzene) to form a 20% solution and 5g of this solution
 was extracted with 5g water by shaking the two phases in a
 centrifuge glass and subsequently separating the phases by
 centrifugation. The aqueous phase was separated and the re-
 25 maining organic phase was subsequently extracted with addi-

tional 5g portions of water. The analysis showed that 70% of the trifluoromethansulphonic acid was extracted in the first extraction, a further 21% were extracted in the second extraction and 5% were extracted in the third extraction. The remaining 4% were extracted in 3 subsequent extractions.